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CODE FOR DESIGNATION OF COPPER
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(*First Revision*)

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CODE FOR DESIGNATION OF COPPER AND COPPER ALLOYS

(*First Revision*)

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Indian Standard
**CODE FOR DESIGNATION OF COPPER
AND COPPER ALLOYS**
(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 28 February 1974, after the draft finalized by the Metal Standards Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This Standard was first published in 1963. As a result of the experience gained during these years, it has been decided to revise this standard. The major modification in this standard relates to changes in symbols for temper designation to bring it in line with the international practice.

0.3 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS: 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard specifies the symbols which shall be used for the designation of copper and copper alloys on the basis of chemical composition, physical condition, etc.

2. GENERAL

2.1 Copper and copper alloys may be designated by a group of symbols indicating the important characteristics in the following order:

- a) Chemical composition
- b) Special requirements

2.1.1 If there are more than one symbols under any of the above categories, they shall be arranged in the alphabetical order.

*Rules for rounding off numerical values (revised).

2.1.2 Where necessary, the various important and distinct methods of casting may be specified as given below and shall precede the designation:

- G Sand cast
- GC Chill cast
- GD Die cast
- GW Centrifugally cast
- GX Shell moulded or investment cast
- h Hot rolled
- d Cold-worked (rolled, drawn or extruded)
- e Hot extruded
- f Forged

2.1.3 Absence of the symbols mentioned under 2.1.1 shall indicate that the material is in wrought form.

3. SYMBOLS FOR CHEMICAL COMPOSITION

3.1 Symbol for Pure Copper — The symbol 'Cu' shall be followed by the internationally accepted symbols and shall be coded as given in Appendix A.

3.2 Symbol for Copper Alloy (Alloy Index)

3.2.1 The chemical symbol of copper shall be followed by the chemical symbol of the next most significant element after which other significant elements shall be stated in the order of decreasing percentage or, when equal, in alphabetical order. The nominal or average percentage of each alloying element shall be indicated by an index number as given below and shall immediately follow the respective chemical symbol; only the minimum number of symbols necessary to identify the alloy shall be used:

<i>Nominal or Average Alloy Content</i>	<i>Index Number</i>
Up to 1 percent	Only the alloy symbol shall be used in the descending order of percentage content
1 percent and over	The average or nominal alloying content shall be rounded to the nearest whole number (<i>see</i> IS : 2-1960*)

3.2.2 Where two or more significant alloying elements have the same alloy index in an alloy, the chemical symbols shall be grouped together followed by their alloy index.

*Rules for rounding off numerical values (*revised*).

3.2.3 When minimum contents of some minor alloying elements are specified for certain specific purposes, they shall, if necessary, be considered as significant alloying elements and indicated at the end of the designation by their chemical symbols only.

4. SYMBOLS FOR SPECIAL REQUIREMENTS

4.1 Symbol for Rigid Limits for Impurity — Where rigid limits for impurities are specified for workability, and to differentiate between two similar alloys, it shall be indicated by the symbol 'K'.

4.2 Symbols for Surface Finish and Condition — The following symbols shall be used:

J	Bright drawn or bright rolled
J7	Bright pickled
J8	Bright annealed
MC	Machined

4.3 Symbol for Temper Designation

4.3.1 Basis of Designation

4.3.1.1 The temper designations are based on the sequence of basic treatments used to produce the various tempers.

4.3.1.2 The temper designations, which are used for all wrought and cast copper and copper alloy products except ingots, follow the material designations and are separated therefrom by a hyphen.

4.3.1.3 Basic temper designations consist of letters. Subdivisions of the basic tempers, where required, are indicated by a second letter following the letter of the basic temper. These second letters designate a specific sequence of basic treatments, but only those treatments or operations are recognized which significantly influence the product characteristics. Special subdivisions could be indicated by a third letter where necessary.

4.3.2 Basic Temper Designations — Basic temper designations are intended to give a detailed description of the method of manufacture and heat treatment which the product undergoes. These basic temper designation may apply to semi-finished or finished products as well. In case the basic temper designation is used for designation of alloy it may not be necessary to indicate the various methods of manufacture as given in 2.1.1.

O Annealed — Applies to wrought products which are fully annealed and to cast products which are annealed to improve ductility and dimensional stability.

H Strain hardened (for wrought products only). Applies to products subjected to the application of cold work after annealing, or

to a combination of cold work and partial annealing, on stabilizing in order to secure the specified mechanical properties. The 'H' is always followed by a second letter indicating various stages of strain hardening.

- T Thermally treated to produce tempers other than 'M', 'O', or 'H'. Applies to products which have their tensile strength increased by thermal treatment, with or without supplementary strain hardening. The 'T' is always followed by a second letter indicating the specific sequence of treatments.

4.3.3 Subdivisions of Basic Temper Designations

- O Annealed — Without any special requirements for grain size.
- OS For copper and copper alloy products required to be specially annealed to obtain restricted grain size ranges. The designation 'OS' is followed by figures indicating the nominal grain size, the maximum and minimum limits of which are listed for each alloy and product in the relevant document on mechanical properties.
- HA } Various stages of strain hardening. The designations are in
HB } alphabetical order and in ascending order of tensile strength as
HC } indicated in the relevant mechanical property documents.

NOTE — If copper and copper alloys should be stress relieved after strain-hardening to improve stress-corrosion characteristics or dimensional stability after machining, this temper as a special subdivision is indicated by the letter 'R' as a third digit, for example 'HAR', 'HCR'.

- T Thermally treated to produce tempers other than 'M', 'O' or 'H'.
- TA Cooled from an elevated temperature shaping process and naturally aged. Applies to products for which the rate of cooling from an elevated temperature shaping process, such as casting or extrusion, is controlled, or is such that the product is subject to natural ageing. Properties of some alloys in this temper are unstable.
- TB Solution heat-treated and naturally aged. Applies to products which receive no cold work after solution heat treatment except as may be required to flatten or straighten them. Properties of some alloys in this temper are unstable.
- TC Cooled from an elevated temperature shaping process, cold-worked and naturally aged. Applies to products which are subjected to a controlled amount of cold-working following controlled cooling from an elevated temperature shaping process, such as forging or extrusion, to improve strength or reduce internal stresses. Properties of some alloys in this temper are unstable.
- TD Solution heat-treated, cold-worked and naturally aged. Applies to products which are subjected to a controlled amount of

cold-working following solution heat treatment to improve strength or reduce internal stresses. Properties of some alloys in this temper are unstable.

- TE** Cooled from an elevated temperature shaping process and precipitation treated. Applies to products which are precipitation-treated following cooling from an elevated temperature shaping process, such as casting or extrusion. May be achieved by precipitation treatment of 'TA' temper products or, in some cases, by precipitation treatment of 'M' temper products.
- TF** Solution heat-treated and precipitation-treated. Applies to products which are precipitation-treated following 'TB' treatment.
- TG** Cooled from an elevated temperature shaping process, cold-worked and precipitation-treated. Applies to products which are precipitation-treated following a 'TC' treatment.
- TH** Solution heat-treated, cold-worked and precipitation-treated. Applies to products which are precipitation-treated following a 'TD' treatment.
- TK** Cooled from an elevated temperature shaping process, precipitation-treated and cold-worked. Applies to products which are subjected to a controlled amount of cold-working following a 'TE' treatment.
- TL** Solution heat-treated, precipitation-treated and cold-worked. Applies to products which are subjected to a controlled amount of cold-working following a 'TF' treatment.

5. EXAMPLES

5.1 In order to illustrate, examples of code designations in accordance with this standard are given below:

Example 1: Cathode copper (*see* IS : 191-1967*):

<i>Element</i>	<i>Percent</i>	<i>Designation</i>
Copper	99.90, <i>Max</i>	Cu CATH
Bismuth	0.001, <i>Max</i>	
Lead	0.005, <i>Max</i>	
Total impurities	0.03, <i>Max</i>	

*Specification for copper (*second revision*).

Example 2: Copper sheet (*see* IS : 288-1960*), hot rolled:

<i>Element</i>	<i>Percent</i>	<i>Designation</i>
Copper	99.20	} Cu ATph
Arsenic	0.30 to 0.50	
Antimony	0.05, <i>Max</i>	
Bismuth	0.002, <i>Max</i>	
Oxygen	0.10, <i>Max</i>	
Lead	0.01, <i>Max</i>	

Example 3: Brass sheet (*see* IS : 410-1967†) in annealed temper:

<i>Element</i>	<i>Percent</i>	<i>Designation</i>
Copper	68.5 to 71.5	} Cu Zn 30-0
Lead	0.07, <i>Max</i>	
Iron	0.05, <i>Max</i>	
Total impurities	0.20, <i>Max</i>	
Zinc	Remainder	

Example 4: Brass sheet (*see* IS : 410-1967†) in the bright pickled condition:

<i>Element</i>	<i>Percent</i>	<i>Designation</i>
Copper	61.5 to 64.5	} Cu Zn 37 J 7
Lead	0.30, <i>Max</i>	
Iron	0.10, <i>Max</i>	
Total impurities	0.55, <i>Max</i>	
Zinc	Remainder	

Example 5: Brass, gravity die cast (*see* IS : 1264-1965‡):

<i>Element</i>	<i>Percent</i>	<i>Designation</i>
Copper	61.0, <i>Min</i>	} CD Cu Zn 38 Sn 1
Tin	0.5 to 1.5	
Aluminium	0.5, <i>Max</i>	
Lead	0.1, <i>Max</i>	
Total impurities	0.75, <i>Max</i>	
Zinc	Remainder	

*Specification for copper rods for boiler stay bolts and rivets (*revised*).

†Specification for rolled brass plate, sheet, strip and foil (*second revision*).

‡Specification for brass ingots for gravity die castings and brass gravity die castings (including naval brass) (*revised*).

Example 6: Phosphor bronze strip (*see* IS : 1385-1965*) in the strain hardened condition:

<i>Element</i>	<i>Percent</i>	<i>Designation</i>
Tin	3.0 to 4.5	} Cu Sn Pb 4 Zn 3-H
Phosphorus	0.02 to 0.040	
Lead	3.5 to 4.5	
Zinc	1.5 to 4.5	
Copper, tin and phosphorus	99.5, <i>Min</i>	

Example 7: Leaded tin bronze sand castings, Grade I (*see* IS : 318-1962†):

<i>Element</i>	<i>Percent</i>	<i>Designation</i>
Tin	6.0 to 8.0	} G Cu Sn 7 Zn 5 Pb2
Zinc	4.0 to 6.0	
Lead	1.0 to 3.0	
Antimony	0.3, <i>Max</i>	
Iron	0.35, <i>Max</i>	
Total of all other impurities	0.5, <i>Max</i>	
Copper plus incidental nickel	Remainder	

Example 8: Leaded tin bronze chill castings, Grade 4 (*see* IS : 318-1962†):

<i>Element</i>	<i>Percent</i>	<i>Designation</i>
Tin	6.0 to 8.0	} G K Cu Pb 15 Sn 7
Zinc	0.5, <i>Max</i>	
Lead	14.0 to 16.0	
Antimony	0.3, <i>Max</i>	
Iron	0.35, <i>Max</i>	
Total of all other impurities	0.5, <i>Max</i>	
Copper plus incidental nickel	Remainder	

*Specification for phosphor bronze rods and bars, sheet and strip, and wire.

†Specification for leaded tin bronze ingots and castings (*revised*).

Example 9: Brass sheet (see IS : 422-1967*):

<i>Element</i>	<i>Percent</i>	<i>Designation</i>
Copper	58.5 to 61.5	} Cu Zn 39 K
Lead	0.05, <i>Max</i>	
Tin	0.05, <i>Max</i>	
Iron	0.10, <i>Max</i>	
Total impurities	0.20, <i>Max</i>	
Zinc	Remainder	

Example 10: Brass sheet (see IS : 422-1967*):

<i>Element</i>	<i>Percent</i>	<i>Designation</i>
Copper	58.5 to 61.5	} Cu Zn 39
Lead	0.3, <i>Max</i>	
Tin	0.10, <i>Max</i>	
Iron	0.15, <i>Max</i>	
Total impurities	0.75, <i>Max</i>	
Zinc	Remainder	

Example 11: Brass sheet (see IS : 422-1967*) in the bright rolled condition:

<i>Element</i>	<i>Percent</i>	<i>Designation</i>
Copper	58.5 to 61.5	} Cu Zn 39 J
Lead	0.05, <i>Max</i>	
Tin	0.05, <i>Max</i>	
Iron	0.10, <i>Max</i>	
Total impurities	0.20, <i>Max</i>	
Zinc	Remainder	

APPENDIX A

(Clause 3.1)

DESIGNATION FOR PURE COPPER

A-1. The designation of different grades of pure copper in accordance with IS : 191-1967† shall be as given below:

Cathode copper	CuCATH
Electrolytic tough pitch copper	CuETP
Fire-refined high conductivity copper	CuFRHC

*Specification for brass sheet and strip for the manufacture of utensils.

†Specification for copper (second revision).

Fire-refined tough pitch copper, Grade 1	CuF RTP-1
Fire-refined tough pitch copper, Grade 2	CuF RTP-2
Arsenical, tough pitch copper	Cu ATP
Phosphorized, high residual phosphorus, non-arsenical, Grade 1	Cu DHP-1
Phosphorized, high residual phosphorus, non-arsenical, Grade 2	Cu DHP-2
Phosphorus deoxidized arsenical copper	Cu DPA
Oxygen-free high conductivity copper	Cu OF

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	Unit	Symbol
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	Unit	Symbol	Conversion
Force	newton	N	1 N = 1 kg·1 m/s ²
Energy	joule	J	1 J = 1 N·m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V·s
Flux density	tesla	T	1 T = 1 Wb/m ²
Frequency	hertz	Hz	1 Hz = 1 c/s (s ⁻¹)
Electric conductance	siemens	S	1 S = 1 A/V
Pressure, stress	pascal	Pa	1 Pa = 1 N/m ²

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